

CLAIMS

What is claimed is:

1. A heating element protection apparatus for a mass-flow sensor comprising:
a heating element disposed in a gas;
a heating element controller supplying power to the heating element to replace heat dissipated by said gas;
a slope detector for measuring a slope of a temperature of said heating element as power is supplied to said heating element;
wherein the power is switched off for a predetermined period of time if a magnitude of the slope is greater than a reference magnitude.
2. The heating element protection apparatus for a mass-flow sensor of claim 1, further comprising a gas temperature sensor disposed in said gas to sense a temperature of said gas;
wherein the heating element controller detects a temperature of said heating element and supplies power to the heating element based on said heating element temperature and said gas temperature
3. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein after the power is switched off for said predetermined period of time an open loop ramp up is restarted.
4. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein said reference magnitude is 500° C/second.
5. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein said predetermined period of time is between about one and three seconds.

6. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein:

said temperature is an electrical signal;

said slope detector measures a tangent of said electrical signal; and

said magnitude of said slope is a magnitude of said tangent.

7. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein the power is switched off for said predetermined period of time if said heating element temperature is greater than about 450° C.

8. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein the power is switched off for said predetermined period of time if said heating element temperature is less than about 350° C.

9. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein the power is switched off for said predetermined period of time if said power is greater than about 30 watts.

10. The heating element protection apparatus for a mass-flow sensor of claim 1, wherein said slope is an instantaneous slope.

11. A method of protecting a heating element for a mass-flow sensor, the method comprising:

disposing a heating element in a gas;

detecting a temperature of said heating element;

supplying power to the heating element to replace heat dissipated by said gas;

measuring a slope of said temperature with a slope detector as said power is supplied to said heating element; and

switching off the power for a predetermined period of time if a magnitude of the slope is greater than a reference magnitude.

12. The method of protecting a heating element for a mass-flow sensor of claim 11, the method comprising further:

disposing a gas temperature sensor in said gas;

sensing a temperature of said gas; and

supplying power to the heating element to replace heat dissipated by said gas based on said heating element temperature and said gas temperature.

13. The method of protecting a heating element for a mass-flow sensor of claim 11, the method comprising further restarting an open loop ramp up.

14. A system of protecting a heating element for a mass-flow sensor comprising:

means for disposing a heating element in a gas;

means for detecting a temperature of said heating element;

means for supplying power to the heating element to replace heat dissipated by said gas;

means for measuring a slope of said temperature as said power is supplied to said heating element; and

means for switching off the power for a predetermined period of time if a magnitude of the slope is greater than a reference magnitude.

15. The system of protecting a heating element for a mass-flow sensor of claim 14, the system comprising further:

means for disposing a gas temperature sensor in said gas;
means for sensing a temperature of said gas; and
means for supplying power to the heating element to replace heat dissipated by
said gas based on said heating element temperature and said gas temperature.

16. The system of protecting a heating element for a mass-flow sensor of claim
14, the system comprising further means for restarting an open loop ramp up.